ELECTRON-IMPACT EXCITATION OF THE $A^3\Sigma^+_u$, $B^3\Pi_g$, $W^3\Delta_u$ AND $a^1\Pi_g$ STATES OF N_2 AT LOW ENERGIES

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Electron-impact excitation of electronic states in N_2 has been, in general, extensively investigated. Most of the cross section data are available in the intermediate (15 to 100 eV) or high (above 100 eV) impact energy ranges. There is, however, a critical gap in the electron-impact excitation cross section data in the 10 to 15 eV impact energy range. Data at these low energies are needed for understanding electron-impact-induced processes in aeronomy as well as for checking theoretical models and approximations. At the same time, high-level calculations can provide insights regarding the origins of observed features in the cross sections.

The aim of the present experimental and theoretical work is to fill the existing gap by investigating direct excitation of the seven lowest electronic states ($A^3\Sigma_u^+$, $B^3\Pi_g$, $W^3\Delta_u$, $B'^3\Sigma_u^+$, $a'^1\Sigma_u^-$, $a^1\Pi_g$ and $w^1\Delta_u$, from here on designated as A, B, W, B', *a'*, *a* and w) in N_2 in the low impact-energy range. These states heavily overlap and constitute a group of excitation features in the 6.5 to 10.8 eV energy-loss region. Cross sections for the relatively strong A, B, W and *a* states excitations were measured. The weak features associated with the w, B' and *a'* states are heavily overlapped by other strong transitions in the energy-loss spectra and are very difficult to observe. Therefore, only estimates for the contributions from these excitations to our energy-loss spectra were made and cross section values will not be given.

A crossed-beam experimental arrangement was employed. Nearly monoenergetic electrons at the desired impact energy, produced by an energy-selected gun, crossed the target beam at 90°. The target N_2 beam was formed by effusing the gas through a capillary array with a few torr back-pressure. Energy-loss spectra, including both the elastic peak and the inelastic region of interest, were obtained from 10° to 130° scattering angles at 10, 12.5 and 15 eV impact energies utilizing multi-channel-scaling techniques. The procedure for obtaining the absolute cross sections consisted of two steps. In the first step, we followed the method described by Nickel et al.[1] using the elastic differential cross sections (DCS's) of Shyn and Carignan[2]. In the second step, we renormalized the cross section data obtained in the first step, using the inelastic to elastic DCS ratios obtained from the electron time-of-flight (TOF) measurements of LeClair and Trajmar.[3]

The cross section calculations employed the Schwinger multichannel (SMC) method. Several different coupling schemes were used, with varying numbers of open channels included in the calculation, in order to explore the sensitivity of the results to channel-coupling effects.

Both experimental and theoretical differential and integral excitation cross sections corresponding to the A, B, W and *a* state excitations at 10.0, 12.5 and 15.0 eV electron-impact energies will be reported. Table 1 summarizes the measured integral excitation cross sections.

Table 1. Summary of measured integral excitation cross sections (10^{-18} cm^2) for states A, B, W and *a*.

Energy (eV)	A	B	W	a
10	36.4	-	-	-
12.5	12.7	25.3	18.5	17.9
15.0	12.9	17.8	28.7	30.3
Error ± %	21	21	21	21

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